Factors Controlling Concentration of Metals in the Leachate from Aerobic and Anaerobic Laboratory Landfill Bioreactors

Michael R. Greenberg, Terry C. Hazen, Sharon E. Borglin, and Curtis M. Oldenburg

AGU indexes: 1065, 1615, 1694, 1699, 1831

Costs and environmental issues associated with operating municipal landfills have motivated laboratory experiments investigating methods to increase biodegradation and decrease fugitive emissions of both liquid and gas. Rates of settling, biodegradation, and emissions were measured in three large laboratory-scale bioreactors filled with 30 kg of typical municipal waste. The bioreactors (200-L clear acrylic tanks) were instrumented to monitor pressure, temperature, moisture, humidity, gas composition, and leachate composition. Three treatments were applied: 1) aerobic (air injection with water addition and recirculation), 2) anaerobic (no air injection, water addition and recirculation), and 3) a control tank (no air or water injection). Preliminary studies showed measurable concentrations of Fe, Ba, Cu, Al, Mn, Ni, and Zn in the leachate. To investigate this further, bi-weekly leachate samples were, and were analyzed for dissolved Fe, Ba, Cu, Al, Mn, Ni, Zn. NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, SO_4^{2-}, Cl^-, Fl^-, Na^+, Ca^2, total organic acid, Eh and pH. The aerobic tank leachate had metals concentrations that were an order of magnitude lower than the leachate from the anaerobic tank. Possible explanations include the existence of fewer organic-metal complexes due to the decrease in the dissolved organic matter in the leachate for the aerobic treatment, or the higher pH and redox potential in the aerobic treatment. A sensitivity analysis was performed using MINTEQA2, a U.S. EPA geochemical speciation model that reports on metal speciation based on water composition parameters, for a combination of actual and estimated data. Initial results suggest that the presence of certain organic acids dramatically increases the metal-organic complexation, consistent with observations of greater metal concentrations in the anaerobic treatment leachate.

Supported by Laboratory Directed Research and Development Funds at Lawrence Berkeley National Laboratory under Department of Energy Contract No. DE-AC03-76SF00098.